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STUDIES ON THE WASTES OF A NAVAL STORES PLANT

Virgil A. Minch, et al

Environmental Health Center
Cincinnati, Ohio

1950

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Industrial Waste Survey Report

GULF NAVAL STORES COMPANY

Gulfport, Mississippi

December 5 to December 15, 1950

Studies on the Wastes of a

Naval Stores Plant

By

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ABSTRACT

This study was undertaken as part of the Public Health Service program of industrial waste studies. A study was made of the stump washer effluent, and the main outfall and the various components that make up the plant effluent.

Gulf Naval Stores Company operates 12 extractors to produce FF wood rosin, turpentine, pine oil and dipentene. An average of 250 tons of pine stumps are processed daily from which 164 barrels of FF wood rosin, 1200 gallons of turpentine, 1000 gallons of pine oil, and 500 gallons of dipentene are produced.

The stump washer discharges daily 2400 pounds of 5-day B.O.D., 26,000 pounds of suspended solids and 4,000 pounds of dissolved solids.

The main plant outfall discharges daily 3,600 pounds of 5-day B.O.D. and 3,200 pounds of total solids. The Drop Solution Wash is responsible for 34% of the B.O.D. and 23% of the total solids found in the main plant outfall.

As the result of approximately four days detention in the main lagoon, the 5-day B.O.D. was reduced 20%, the O.C. 25% and the total solids 10%.

Population equivalent for this plant was 36,000, B.O.D. basis.

GENERAL INFORMATION

1. Organization of Survey

Arrangements for this cooperative project were made by officials of the Mississippi State Department of Health. The Environmental Health Center was invited to study Gulf Naval Stores wastes by the Basin Engineer for the Southeast Drainage Basin office. Several conferences were held to discuss results of previous studies, analytical procedures, and conduct of the survey.

2. Dates

December 5 to December 15, 1950.

3. Personnel

The following personnel participated in the organization and conduct of the survey:

MISSISSIPPI STATE HEALTH DEPARTMENT
H. A. Kroeze, Director, Division of Public Health Engineering
C. M. Ledbetter, Sanitary Engineer

PUBLIC HEALTH SERVICE
L. A. Young, Southeast Drainage Basins Engineer

MOBILE LABORATORY
Virgil A. Minch, Jr.Asst.San.Engr. (R)
Albert L. Platz, Jr.Asst.San.Engr.
William W. Walker, Chemist
Carl N. Shadix, Chemist
Stephen D. Pinkoski, Chemist
Melvin D. Currey, Chauffeur-Mechanic

4. Purpose

This survey was conducted to determine the quantities and characteristics of process wastes resulting from the operation of a naval stores plant. We were also interested in determining the principal factors influencing the characteristics of naval stores plant wastes. Results of this work and similar studies will serve as basis for preparation of an industrial waste guide on naval stores wastes.

5. Location of Plant

The plant and offices are located along Creosote Road approximately five

miles north of Gulfport, Mississippi

6. Raw Materials

The principal raw material is the stump of the long leaf yellow pine (Pinus palustris Miller). The stump of the slash pine (Pinus caribaea Morelet) could be used if available.

The stumps should have aged from ten to twenty years to allow less durable portions with small resin content to be removed by decay. There is also a considerable change in the composition of the resinous content during the aging period.

The stumps are removed from fields up to sixty-five miles from Gulfport, that being considered the economic limit of haul. It is estimated that there is an eight-year supply of suitable stumps remaining in the Gulfport area.

The average daily intake of raw materials at this plant is as follows:

Pine stumps	250 tons*
Naphtha, Petroleum (200-240°F)	1000 gallons
Lime (for limed rosin)	250 pounds
Caustic Soda	25 pounds

* The plant capacity is 275 tons.

7. Production

The average daily outputs of naval stores products were reported as follows:

FF Wood Rosin (Includes limed rosin)	164 barrels (420 lbs. each)
Turpentine	1200 gallons
Pine Oil	1000 gallons
Dipentene	500 gallons
Limed Rosin	15 drums (546 lbs. each)

8. Operations

Operations at this plant are constant and are carried on 24 hours a day (3 shifts, 7:00 AM - 3:00 PM - 11:00 PM) seven days a week.

The plant is shut down for scheduled repairs and maintenance for 3 to 6 days around the Christmas holidays.

9. Employees

Exclusive of salaried personnel, the plant employs 100 persons, 44 of which are on the day shift, 28 on the swing shift, and 28 on the graveyard shift. Sixteen of the men on the day shift are maintenance personnel.

Some 300 additional employees work in the field, removing stumps from the ground and trucking the stumps to the plant.

10. Water Supply

Water for use at the plant is drawn from five deep wells (1000-1200 ft.) These wells are normally artesian (flowing) but the low rate of discharge necessitates pumping part of the time.

Water consumption figures were not available as the artesian flow was not constant, and the pumps operated automatically as needed, but the daily net consumption was estimated to be 1.40 million gallons. Used condenser water is returned to one of the two cooling basins for later re-use. The recirculation rate through the cooling units and spray ponds was given as 2000-2500 gallons per minute.

11. Waste Disposal

All process wastes from the plant (except the stump washer) are discharged into a concrete drain (36" wide, 12" deep) running through the plant proper. The drain discharges into a chambered oil separator basin, approximately 10' x 60' x 5', where some of the solids and oils are removed.

A velocity of 1.95 feet per minute is provided when the chambers are empty of solids. The effluent from the oil separator basin is retained in a lagoon for approximately four days before being discharged into the Bayou Bernard. The effluent from the stump washer is ditched 1/4 mile to the bayou with no other detention being provided. Heavy suspended solids are deposited en route but appreciable quantities of chips and finely divided solids are discharged into the bayou.

12. Sanitary Wastes

The sanitary facilities consist of two outdoor privies and two bathhouses. The wastes from the bathhouses discharge into the turbine condensate pond while the privies discharge directly into the bayou.

Indoor water closets are planned for April, 1951.

A water-carriage system is provided for the offices and laboratory with disposal to a septic tank and tile field.

DISCUSSION OF PROCESS

The process consists of passing naphtha through shredded pine chips to remove rosin, pine oil, turpentine, and dipentene, all of which are recovered in subsequent operations. The general operation of the plant is outlined below. The flow chart for the various phases is given in Figure 1.

13. Unloading Stumps

The pine stumps are brought into the plant on flat-bed trucks, each carrying slightly less than ten tons. The stumps are unloaded by means of a crane equipped with a set of 4-way tongs (known as orange-peel buckets). These can best be described as two pairs of ice tongs set at right angles to each other, with

broad jaws having serrated edges to facilitate gripping several tons of stumps at a time.

The stumps are either placed directly on a heavy chain conveyor or on adjacent stockpiles if not immediately needed. The stockpiles are capable of holding a two-year supply of stumps, but ordinarily only a few days supply is kept to be used when the trucks cannot enter the fields during and after rainstorms.

14. Stump Washing

The chain conveyor draws the stumps up an inclined trough and dumps them into a tumbler washer where earth and rotten wood are removed under steady streams of water. The effluent from the tumbler washer is passed through a rotating screen where the larger wood chips are salvaged. The stump washer effluent proved to be a serious offender, contributing daily to the bayou more solids than the main plant effluent.

15. Size Reduction

The clean stumps are passed to the hog shredder which reduces them to chips 2"-3" in length and 1/4" in diameter. These chips are fed into a rotary shredder for further reduction in size. The final reduction in size is accomplished by a pair of rotary shredders working in parallel to deliver wood chips 1/2" to 1 1/2" in length and 1/8" in diameter. This size is considered optimum, allowing the maximum rate of extraction, with the minimum of difficulty in handling. These chips are delivered to the fresh chip storage bin to await processing.

The stump washer and shredders are operated during the evening and night shifts only, unless the fresh chip supply is seriously depleted on the day shift.

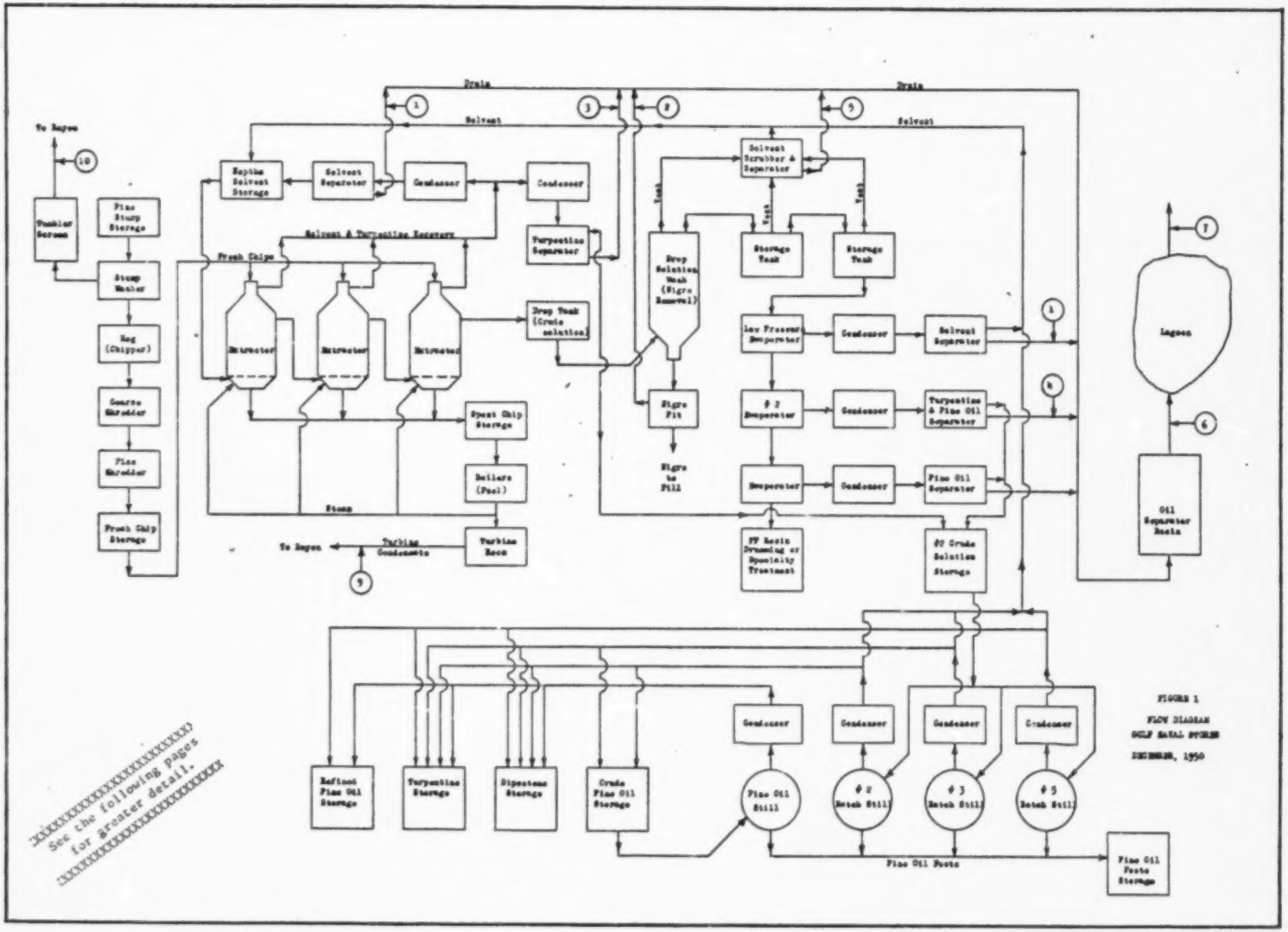

FIGURE 1
FLOW DIAGRAM
GULF NAVAL STORES
DECEMBER, 1950

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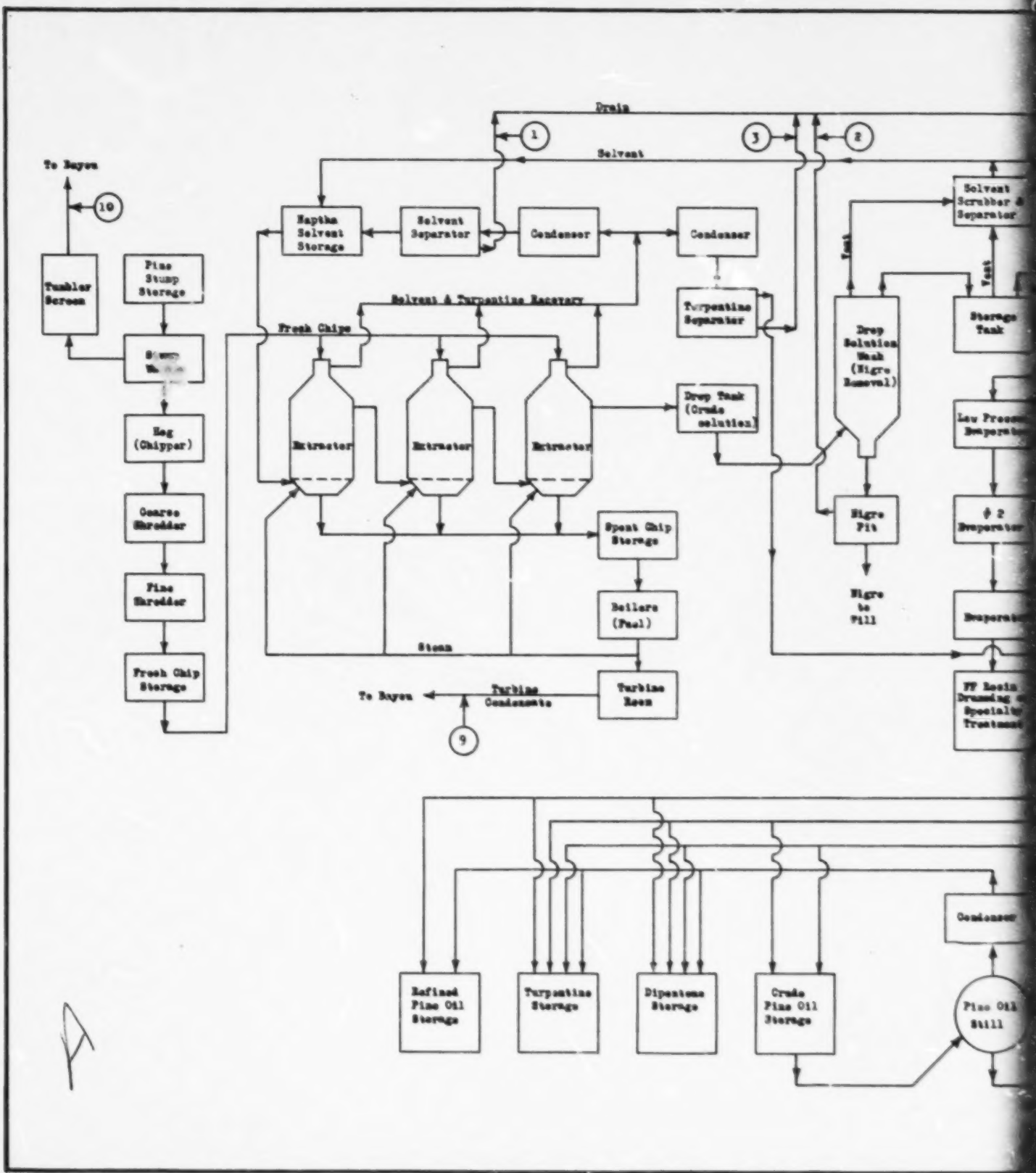
Drain
1
3
2
Solvent
To Buyer
10
Tumbler Screen
Pine Stump Storage
Hog (Chipper)
Coarse Shredder
Fine Shredder
Fresh Chip Storage
Naptha Solvent Storage
Solvent Separator
Condenser
Condenser
Solvent & Turpentine Recovery
Fresh Chips
Extractor
Extractor
Extractor
Turpentine Separator
Drop Tank (Crude solution)
Spent Chip Storage
Boilers (Fuel)
Steam
To Buyer
Turbine Condensate
Turbine Room
9
Drop Solution Wash (Nigre Removal)
Nigre Pit
Nigre to Pill
Solvent Scrubber & Separator
Vent
Vent
Storage Tank
Lav Press Evaporator
2 Evaporator
Evaporator
FF Rosin Drumming & Specialty Treatment
Refined Pine Oil Storage
Turpentine Storage
Dipentene Storage
Crude Pine Oil Storage
Condenser
Pine Oil Still

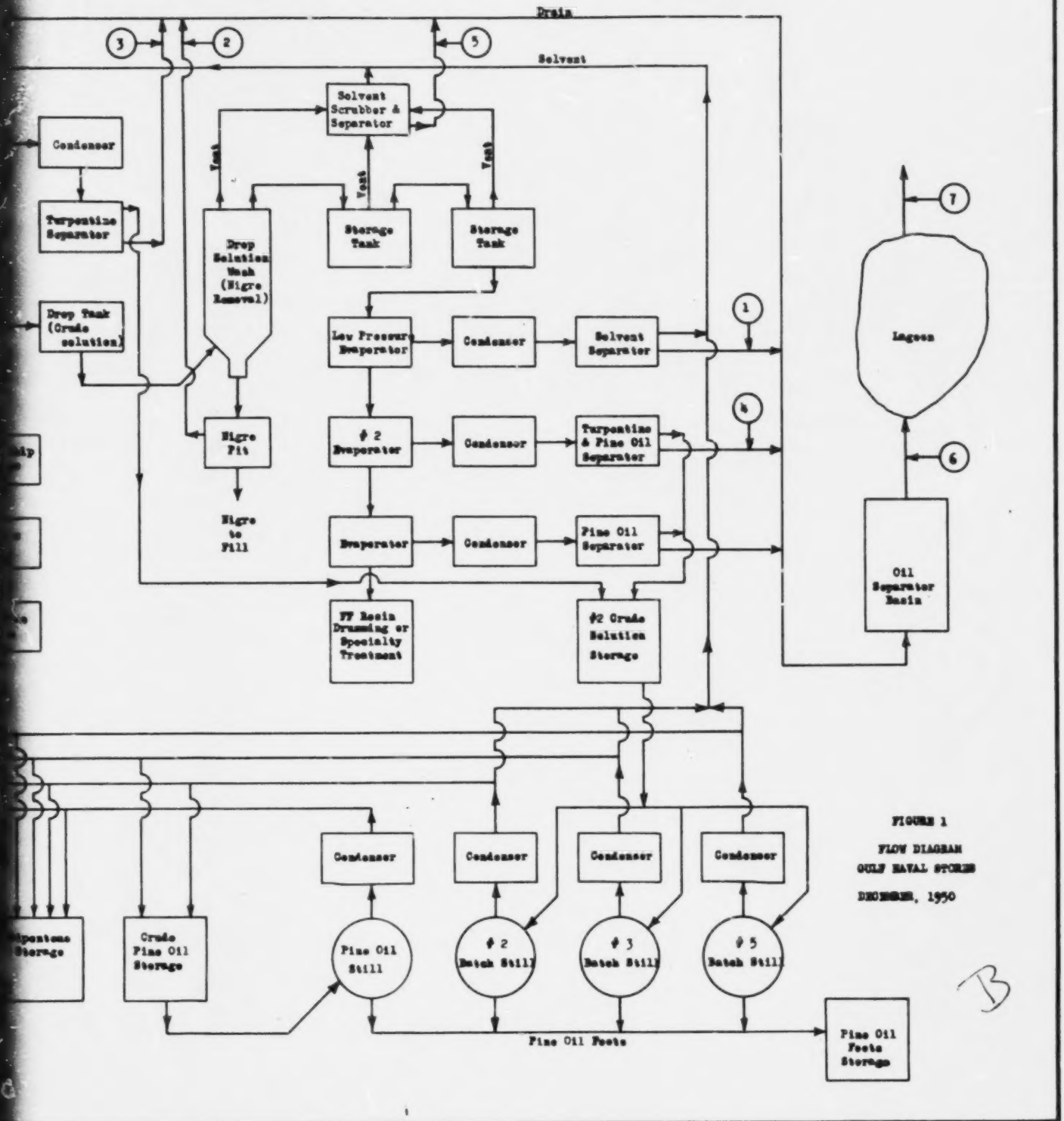

FIGURE 1

FLOW DIAGRAM

GULF NAVAL STORES

DECEMBER, 1950

B

16. Extraction

Fresh chips are removed from the bottom of the storage bin by an endless belt and carried to the top of the extractor house, where they can be placed in any of the extractors. The chips are packed tightly into the extractor and all openings bolted shut. There are 12 extractors, each holding 5 tons of chips. The extractors are worked seven in a cycle, the fresh solvent being introduced into the extractor containing the most exhausted chips, and the loaded solvent being passed last through the freshest chips. The temperature of the solvent is 260°-300°F. at a pressure of 110-90 psi, gage.

Solvent is pumped through the series for 30 minutes at the rate of 100 gallons per minute; then the oldest extractor is cut out of the series and a new one added. Each extractor remains in the extraction cycle for 3 hours and 30 minutes during which time 21,000 gallons of solvent have passed through. As soon as an extractor has been cut out, it is steamed for seventeen minutes for the recovery of solvent and twenty-eight minutes for the recovery of remaining turpentine. The recovered solvent is separated from the steam condensate and returned to the solvent system. The turpentine is condensed, separated, and piped to the No.2 crude solution tank to await fractionation.

The spent chips are removed manually from a door near the bottom of the extractor. Since some solvent and volatile products may still be in the chips, there is a distinct fire hazard, but Gulf Naval Stores, has, at the same time, solved both this problem and that of conveying the spent chips. The chips are dropped into an air suction pipe. Here they are dried while being blown into the spent chip bin, where they are stored until needed for furnace fuel.

The crude solution, which consists of naphtha, turpentine, pine oil. dipentene, and approximately 8% rosin, is pumped to an overhead drop tank for temporary storage.

17. Drop Solution Wash

The crude solution is passed through one of the two drop solution wash tanks where contact with water causes "nigre" (see note) to separate from the solution.

Note: Nigre (sometimes niger) is the dark, oxidized resinous material present in, and extracted from, wood along with rosin, and subsequently removed therefrom by washing, or selective extraction or absorption.

The nigre is drawn from the drop solution wash tanks every other day, and allowed to cool and solidify in nigre pits. As commercial uses for nigre are somewhat limited, it is used chiefly for fill at the plant.

The crude solution is then admitted to the first of a pair of settling tanks, where some of the solid impurities are removed by sedimentation. These tanks are cleaned once a week.

18. Evaporators

The crude solution is passed to three evaporators (technically, successive equilibrium distillations) operated in series. The first evaporator is operated at a temperature and pressure (10" hg. vacuum and 110 psi ga steam) sufficient to remove the naphtha. This solvent is condensed and replaced in the solvent system. The No.2 evaporator removes more of the solvent and part of the pine products (22-24" hg vacuum and 130 psi ga steam). The distillate from this phase is passed through a separator (Turpentine and Pine Oil Separator) and admitted to the No. 2 Crude Solution Tank. Crude solution at this point consists of naphtha, turpentine, pine oil, dipentene, and pine oil foots.

The third evaporator removes the remainder of the liquid products (25" hg vacuum and 130 psi ga steam), the balance of the residue being FF wood rosin. The rosin is piped to the rosin shed for drumming and cooling or speciality treatment such as liming.*

19. Batch Fractionation

Stills No. 2, 3, & 5 are charged directly from the No. 2 crude solution tank.

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* Lime is added for modification of the melting point of rosin, according to the following schedule:

2%	195°F
3%	210°F
4.75%	250°F
6%	260°F

Still No. 5 produces finished pine oil, turpentine, and dipentene, the residual pine oils foots at the end of the run being drawn off to storage. Stills Nos. 2 & 3 produce turpentine, dipentene, crude pine oil, and pine oil foots. The crude pine oil is placed in storage until a sufficient amount is available to charge the pine oil still (No. 1). After being used two or three times, the stills must be cleaned with caustic solution to remove accumulations of residue. The volume of each wash is estimated to be 50 gallons.

20. Rosin Shed

The rosin, as it is received from the third evaporator, is drummed while in the molten state. Each drum contains 520 pounds* of FF wood rosin. Large orders for rosin may be delivered in tank cars. Some work has been done recently to determine the feasibility of packaging rosin in 100-lb paper sacks with multiple linings, for the convenience of those customers who object to handling the larger containers.

21. Bottling Room

The turpentine, pine oil, pine oil foots, and dipentene are bottled, canned, or drummed in containers designed for the retail trade.

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* Where the drum is sealed after filling, the net weight of rosin is 520 pounds. Where the drum is "capped" (refilled after the initial pour has cooled and shrunk) the net weight of rosin is 546 pounds. As rosin drums are not reusable, it is often economical to cap the drums to utilize the extra space. Capping is practiced at Gulf Naval Stores.
The barrel (420 pounds) is used as the unit of production.

SURVEY PROCEDURES

22. Sample Collection

During the survey, samples were collected by plant personnel from the following sources: stump washer, drop solution wash, turpentine separators, solvent separators, solvent scrubbers, turpentine and pine oil separators from evaporators, plant effluent to lagoon, and turbine condensate pond effluent (including boiler blowdown). These samples were taken at one-hour intervals between 11:00 PM and 7:00 AM, and composited.

During the same period, a grab sample of the lagoon effluent to Bayou Bernard was taken at 8:00 AM each day. For the second week of the sampling period, an additional morning grab sample of the Bayou Bernard Receiving Water was taken at the junction of the lagoon effluent and the bayou. This was a surface sample, and taken approximately 20 feet from shore, and influenced somewhat by the tide.

23. Flow Measurements

The final plant effluent to the lagoon was measured by means of a one-foot rectangular sharp-crested weir which was installed for the duration of the survey. The head on the weir was checked hourly by the sampler by reference to an established point, and the flows were computed from Francis' Formula:

$$Q = 3.33\,LH^{3/2}$$

where Q = flow in cubic feet per second

L = length of weir in feet

H = head on weir in feet

The lagoon effluent was considered to have the same discharge as the plant effluent, because only small amounts of cooling water were added from the limed rosin plant. Evaporation and seepage from the lagoon were also neglected.

The balance of the flow measurements were made volumetrically by accurately timing the filling of a fifteen-gallon container.

The drop solution wash measured twice daily and the average flow for the two weeks was assumed to be the daily flow for the purposes of the calculations. Rate of flow was erratic, varying from 10.2 GPM to 97.8 GPM.

24. Laboratory Procedures

All or part of the following determinations were made on the samples collected:

B. O. D. - 5 days at 20°C.

Sulfides

Chlorides

pH

Oxygen Consumed

Alkalinity

Color

Total Solids, volatile and fixed

Suspended Solids, volatile and fixed

The procedures followed in making the above analyses are, in general, as given in "Standard Methods for the Examination of Water and Sewage," 9th Edition. The modification of the procedure used for the determination of oxygen consumed is given in the appendix of this report.

EXPLANATION OF LABORATORY DETERMINATIONS

25. Sulfur Compounds

Sulfur is found in wastes from industrial plants as hydrogen sulfide, thiosulfate, and other compounds. The sulfide content is important from the standpoint of stream pollution because sulfides are easily oxidized and create immediate oxygen demand in the receiving stream. Hydrogen sulfide has been reported as toxic to fish in concentrations as low as 0.1 part per million.

26. Chlorides

The chloride content of water has considerable significance from a sanitary standpoint. Chlorides are present in all natural water, particularly near the ocean and in the vicinity of salt deposits. Chloride in water may also be derived from oil field wastes, sewage and industrial wastes. The finding of more chloride in a sample of water than would be normal for the region is a strong indication of contamination from outside sources.

27. pH Value

The symbol "pH" denotes the logarithm of the reciprocal of the hydrogen ion concentration in a given water, this symbol being a universal one in chemistry. The pH value indicates the relative acidity or alkalinity of a water or waste, being lower with higher degrees of acidity. It is a measure of intensity rather than quantity.

28. Alkalinity

Alkalinity of a water or waste represents its content of carbonates, bicarbon-

ates, hydroxides, and very occasionally borates, silicates, and phosphates of the alkali and alkali earth metals. By use of the phenolphthalein end points, the amounts of alkalinity that are present can be determined.

29. Biochemical Oxygen Demand (B. O. D.)

The biochemical oxygen demand of the sewage, sewage effluents, polluted waters, or industrial wastes, is the oxygen required during stabilization of the decomposable organic matter by aerobic bacterial action. Since this is a phenomenon into which both time and temperature enter, a standard set of conditions (5 days, 20°C.) is universally used for the test. For normal domestic sewage and some industrial wastes, approximately 68 per cent of the oxygen requirements of the carbonaceous material is satisfied during the standard test. Because of the variable carbon-nitrogen ratio of industrial wastes, however, the rate of oxygen demand of such wastes may not follow the typical oxidation curve for domestic sewage.

30. Color

True color in water is due to the presence of coloring matter in solution. Apparent color is due to colored matter which is in suspension in the water and which can be removed by sedimentation or filtration. True color is usually caused by extracts of decomposing vegetable matter. For example, the dark color of swamp water is a true color and is due to the tannate and gallate extracted from decaying leaves and bark. Color is expressed as parts per million and is measured by comparing the water sample with prepared standards of potassium chloroplatinate. True color alone was used in the laboratory analyses made at the Gulf Naval Stores Company.

31. Oxygen Consumed

The oxygen consumed test is a measure of the chemical oxidant required to oxidize the organic matter present in a sample under particular standardized conditions. It is expressed as parts per million oxygen. The test is of value in estimating the strength of certain industrial wastes, and in conjunction with the determination of the BOD. It can be used where it would be advantageous to obtain results indicative of oxygen demand strengths in less time than the biochemical oxygen demand test requires.

32. Solids

Solids analyses include those for total solids, suspended solids, and the volatile constituents of each. Total solids consist of all the solids present in a liquid, the term includes both suspended solids and dissolved solids. Suspended solids are in suspension or float on the surface of water, sewage, or other liquid, and are removed by laboratory filtering. Dissolved solids are found by subtracting suspended solids from total solids. Volatile solids are those that are lost upon ignition of total solids (giving total volatile solids) or suspended solids (giving volatile suspended solids). Suspended solids cause water to be turbid and unsightly, and may settle on the bed of the receiving body of water with formation of sludge banks.

33. Population Equivalent

Normal domestic sewages, relatively free from industrial wastes, possess characteristics which are reasonably well defined, and it is, therefore, possible to compare them on a common bacis. Industrial wastes are influenced by the processes

from which they originate and the characteristics are not readily defined by the same standards. The "Population Equivalent" value, therefore, provides a basis on which industrial wastes may be compared to domestic sewages. The coefficient 0.17 pound of 5-day 20°C. B. O. D. per capita per day, used in comparing domestic sewages, has been used in converting the data to a population equivalent basis.

DISCUSSION OF RESULTS

With the exception of the stump washing and size reduction phases, operations were essentially constant during each 24-hour period. The amounts of products are affected by the quality of the stumps. The strengths of the wastes produced cannot be correlated with production because of indeterminate storage periods throughout the process.

The raw water contained only solids in appreciable quantity. The water leaving the plant and various units was compared with the raw water to obtain a fair estimate of the net solids discharged.

Tables I, II and III, show the important findings of the survey. Table I shows the average concentration of significant constituents of the wastes sampled while Table II shows the average daily amount of these constituents discharged from the plant. Table III shows the per cent of significant constituents contributed by each component of the main ditch effluent.

GULF NAVAL STORES SURVEY

UNITED STATES PUBLIC HEALTH SERVICE

Table I - AVERAGE CONCENTRATION OF SIGNIFICANT CONSTITUENTS

No.	Source	Flow	B.O.D. 5 Days 20° C.	Oxygen Consumed	Sulfides as "S"	Total Solids			Suspended Solids		
						Total	Volatile	Fixed	Total	Volatile	Fixed
		MGD	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
1.	Solvent Separators	0.0875	840	1,310	----	324	162	162			
2.	Drop Solution Wash	0.0450	3,130	5,170	----	1,920	1,540	380	146	137	8
3.	Turpentine Separators	0.0509	1,571	2,080	----	256	120	136			
4.	Turpentine & Pine Oil Separator from Evaporator	0.0124	7,500	11,600	----	537	426	111			
5.	Solvent Scrubbers	0.0954	329	919	----	245	94	152			
	Other Sources	0.7629	----	-----	----	292	135	158			
6.	Plant Effluent	1.0540	407	650	----	363	197	166	32	26	6
7.	Lagoon Effluent to Bayou Bernard	1.0540	315	486	0.63	323	150	173	35	24	10
8.	Bayou Bernard Receiving Water	------	219	391	0.34	648	115	533	76	63	13
9.	Turbine Condensate Pond Effluent	0.0588	4.4	----	----	596	102	494	49	25	24
10.	Stump Washer Effluent	0.1877	1,540	16,400	----	19,500	8,800	10,700	16,900	7,700	9,200

GULF NAVAL STORES SURVEY

UNITED STATES PUBLIC HEALTH SERVICE

TABLE II - GROSS QUANTITIES OF SIGNIFICANT CONSTITUENTS DISCHARGED FROM PLANT DAILY

Source	Flow	B.O.D. 5 days 20°C.	Oxygen Consumed	Sulfides as "S"	Total Solids			Suspended Solids		
					Total	Volatile	Fixed	Total	Volatile	Fixed
	MGD	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Solvent Separators	0.0875	619	955	—	238	119	119			
Drop Solution Wash	0.0450	1,210	1,938	—	718	575	144	55	51	4
Turpentine Separators	0.0509	660	882	—	109	51	58			
Turpentine & Pine Oil Separator from Evaporator	0.0124	768	1,198	—	55	44	11			
Solvent Scrubbers	0.0954	262	732	—	195	75	121			
Other Sources	0.7629	—	—	—	1,856	860	1,006			
Plant Effluent	1.0540	3,570	5,707	—	3,190	1,730	1,460	273	221	53
Lagoon Effluent to Bayou Bernard	1.0540	2,880	4,267	5.5	2,840	1,320	1,520	301	215	86
Turbine Condensate Pond Effluent	0.0588	2.1	—	—	290	50	240	24	13	11
Stump Washer Effluent	0.1877	2,420	25,640	—	30,400	13,700	16,700	26,400	12,000	14,400

GULF NAVAL STORES SURVEY

UNITED STATES PUBLIC HEALTH SERVICE

TABLE III - PERCENTAGE CONTRIBUTIONS BY SOURCES*
FOR MAIN DITCH

Source	Flow %	B.O.D. %	O.C. %	Total Solids		
				Total %	Volatile %	Fixed %
Solvent Separators	8.3	17.3	16.7	7.5	6.9	8.2
Drop Solution Wash	4.3	33.9	33.9	22.5	33.2	9.9
Turpentine Separators	4.8	18.5	15.5	3.4	2.9	4.0
Turpentine & Pine Oil Separator from Evaporator	1.2	21.5	21.0	1.7	2.5	0.8
Solvent Scrubbers	9.0	7.4	12.8	6.1	4.3	8.3
Other Sources	72.4	——	——	58.2	50.1	68.5

* Excluding Stump Washer

34. Net Contributions by Plant and Units

Water as found in wells can usually be considered as having a negligible biochemical oxygen demand and oxygen consumed value. The material contributions to the plant load by the well water are found in the solids classifications. Normally, the addition of a potable water to a stream is not considered as pollution, but in the case, such as here, where a ground water having a high mineral content is discharged into a surface stream, the initial mineral content must be considered as well as the process wastes. For the sake of comparison with other naval stores operations using raw water having little or no mineral content, the following should be used:

QUANTITY OF SIGNIFICANT CONSTITUENTS IN POUNDS PER DAY

Constituent	Total in Effluent	Total in Raw Water	Chargeable to Process	Net Unit Waste Per Ton of Stumps
Main Plant				
5-day B.O.D.	3,570	---	3,570	14.3
Oxygen Consumed	5,707	---	5,707	12.8
Total Solids	3,190	2,564	626	2.5
Total Volatile Solids	1,730	1,185	545	2.2
Total Fixed Solids	1,460	1,387	73	0.3
Suspended Solids	273	-----	273	1.1
Stump Washer				
5-day B.O.D.	2,240	-----	2,420	9.7
Oxygen Consumed	25,640	-----	25,640	102.6
Total Solids	30,400	450	29,950	120
Total Volatile Solids	13,700	200	13,500	54
Total Fixed Solids	16,700	250	16,450	66
Suspended Solids	26,400	----	26,400	106

SUMMARY

Based on data and supporting information presented in this report, certain points may be summarized as follows:

35. Quantity of Liquid Wastes Discharged

The average daily plant discharge amounted to 1.054 millions gallons a day, distributed as follows:

Source	Flow MGD	% of Total MGD	Low Flow MGD	High Flow MGD
Solvent Separators	0.0875	8.3	0.0745	0.1005
Drop Solution Wash	0.0450	4.3	0.0450	0.0450
Turpentine Separators	0.0509	4.8	0.0398	0.0572
Turpentine & Pine Oil Separator from Evaporator	0.0124	1.2	0.0113	0.0138
Solvent Scrubbers	0.0953	9.0	0.0908	0.1002
Other Sources*	0.7629	72.4	-----	-----

* (Includes wash water, cooling water, steam condensate, etc.)

26. Quantity of Significant Constituents

Total pounds of significant constituents discharged in the plant daily were as follows:

Constituent	Total in Effluent
5-day B.O.D.	3,570
Oxygen Consumed	5,707
Total Solids	3,190
Total Volatile Solids	1,730
Total Fixed Solids	1,460
Suspended Solids	273

37. Unit Values

The unit values for wastes and constituents resulting from the processing of one ton of stumps are as follows:

	Process Wastes	Stump Washing Wastes
Waste volume, gallons	4,216	750
5-day B.O.D., pounds	14.3	9.7
Total solids, pounds	12.8	120
Population Equivalent (BOD basis-0.17#/cap.)	84	57
Oxygen Consumed, pounds	22.8	100

38. Average Yield

The average yield of rosin and pine products per ton of stumps processed is as follows:

	Actual*	Expected
FF Wood Rosin, barrels	0.66	0.71
Turpentine, gallons	4.88	5.0
Pine Oil, gallons	5.24	4.0
Dipentene, gallons	0.0**	1.5-2.0

* The figures given for actual yield were those for the sampling period.

** During the sampling period, the dipentene was not drawn off separately, but was added to the pine oil. Market conditions govern the production of dipentene.

It is desired to express appreciation to Mr. J. T. Latimer for his keen interest and support of this project. Valuable counsel was received from Mr. Louis Latimer, Sales Manager; Mr. Ray Latimer, Plant Superintendent; Mr. Grayson Rayborn, Plant Chemist, and Mr. Ginn, Assistant to the Plant Superintendent.

APPENDIX

APPENDIX

SPECIAL STUDY

38. Turpentine and Pine Oil Separator

Information from plant personnel indicated that considerable pine oil was being discharged from the turpentine and pine oil separator. Estimates ranged up to 2.0 per cent, hence it was decided to run a gross oil determination on the effluent of the separator.

Mr. Rayborn, the plant chemist, used a 110 milliliter portion in a standard butterfat determination apparatus. The sample was centrifuged at 2000 revolutions per minute for 20 minutes. The volumetric percentage of oil in each daily sample is shown below in tabular form:

Date	% Oil
January 9, 1951	0.18
10	.36
11	.27
12	1.20
13	.54
14	.23
15	.73
16	.27
17	.27
18	.54
19	1.09
20	1.50
21	1.00
22	.18
23	.27
24	.09
25	.55
26	.55
27	.55
28	.55
29	.55
30	-
February 1, 1951	.00
2	.00
January Mean	0.54

The separator was taken out of service on January 30, 1951, and the unit repaired. The benefits derived can be noted in the results of February 1 and 2. Based on the mean discharge of the unit, approximately 67 gallons of pine oil daily were thus recovered.

Standard Definitions of Terms Relating to Naval Stores and Related Products

Abietic Acid, Commercial Grade - A mixture of rosin acids sometimes separated from rosin (or tall oil) in either crystalline or vitreous transparent form, and in which true abietic acid is a typical constituent, along with its isomers.

Colophony - A term denoting medium and high grades of rosin.

Dipentene - A monocyclic terpene hydrocarbon, the optically inactive form of limonene, present in the higher boiling fractions of several kinds of turpentine. Commercial dipentene is rich in dipentene but usually also contains other terpenes and related compounds in varying amount.

Naval Stores - Chemically reactive oils, resins, tars, and pitches derived from the oleoresin contained in, exuded by, or extracted from trees chiefly of the pine species (genus Pinus), or from the wood of such trees.

Oil of Turpentine - The pharmaceutical name of spirits of turpentine which conforms to the requirements of the U. S. Pharmacopoeia.

Oleoresin - Pine gum, the nonaqueous secretion of resin acids dissolved in a terpene hydrocarbon oil which is:

(1) Produced or exuded from the intercellular resin ducts of a living tree,
(2) Accumulated, together with oxidation products, in the dead wood of weathered limbs and stumps.

Pinene - A bicyclic terpene hydrocarbon, the principal constituent of all turpentine, and existing therein in two isomeric forms, alpha- and beta-pinene. The latter is found in appreciable quantity only in gum spirits and sulfate wood turpentine. Pinene not otherwise described usually means alpha-pinene.

Pine Oil - A colorless to amber-colored volatile oil with characteristic pinaceous odor, consisting principally of isomeric tertiary and secondary cyclic terpene alcohols, with variable quantities of terpene, hydrocarbons, ethers, ketones, phenols, and phenolic ethers, the amount and character of which depend on the source and method of manufacture. The three commercial kinds of pine oil are:

(1) Steam-distilled pine oil, obtained from pine wood by steam distillation or by solvent extraction followed by such distillation.
(2) Destructively distilled pine oil, obtained from the lighter distillate from the destructive distillation (carbonization) of pine wood.

(3) Synthetic pine oil, obtained by chemical hydration of terpene hydrocarbons to form terpene alcohols, or by dehydration of terpin hydrate.

Pine Pitch - The dark-colored to black solidified material, somewhat pliant and tenacious, obtained by distilling off practically all the volatile oil from a retort pine tar; the genuine contains no added free rosin.

Pitch, Navy - A pitch obtained by melting rosin with pine tar, with or without rosin distillation residues.

Resenes - As applied to naval stores, those constituents of rosin which cannot be saponified with alcohol alkali, but which contain carbon, hydrogen, and oxygen in the molecule.

Terpene Alcohol - An alcohol directly related to or derived from a terpene hydrocarbon; the following are common examples: terpinol (tertiary-cyclic), borneol (secondary cyclic), geraniol (primary, acyclic), linalool (tertiary acyclic).

Turpentine, (Spirits of) - The volatile oil consisting primarily of a number of terpene hydrocarbons of the general formula $C_{10}H_{16}$, obtained by distilling the oleoresin exuded by or contained in the wood of certain species of pine trees. Four kinds of turpentine are now recognized:

(1) Gum turpentine or gum spirits of turpentine, made from the gum (oleoresin) collected from living trees.
(2) Steam-distilled wood turpentine, obtained from the oleoresin within the wood by steam distillation of the wood direct or of an extract therefrom.
(3) Sulfate wood turpentine, recovered during the conversion of wood to paper pulp by the sulfate process.
(4) Destructively distilled wood turpentine, obtained by fractionation of certain oils recovered by condensing the vapors formed during the destructive distillation of pine wood.

Turpentines, Various:

Canada Turpentine - Same as Canada balsam, the oleoresin obtained from trees of the Canadian silver fir (Abies balsamea).

Sulfite Turpentine - This term is not in good usage, because the volatile oil recovered in the conversion of wood to pulp by the sulfite process consists chiefly of cymene ($C_{10}H_{14}$) rather than pinene and other terpenes.

Venice Turpentine - Same as larch turpentine, the oleoresin of the European larch tree, Larix europa or Larix decidua. The term is also now used widely to describe the clear yellow liquid portion of pine oleoresin, or a synthetic product of similar composition made by dissolving rosin in a terpene solvent.

Turpentine Substitute - This term is not recommended, because its use to describe a paint thinner of mineral oil origin is illegal under the Federal Naval Stores Act.

Resinates, Metallic - Rosin in which part or all of the rosin acids have been chemically reacted with those metals which give soap or salts which are water insoluble. Limed rosin, zinc-treated rosin, and the resinates of lead, cobalt, copper, and manganese, are of the greatest industrial importance.

Rosin - A specific kind of natural resin obtained as a vitreous water-insoluble material from pine oleoresin by removal of the volatile oils. It consists primarily of tricyclic monocarboxylic acids having the general empirical formula $C_{20}H_{30}O_2$, with small quantities of compounds saponifiable only with boiling alcoholic potassium or sodium hydroxide, and some unsaponifiable matter. The two general classifications or kinds of rosin in commerce are:

(1) Gum rosin, obtained from the oleoresin collected from living trees,
(2) Wood rosin, obtained from the oleoresin contained in dead wood, such as stumps and knots.

Rosin, Limed - See "Resinates, Metallic."

Rosin, Limed, or Zinc-Treated - Rosin which has been chemically reacted with a calcium or zinc compound, or both, to form a product containing a metallic salt of the rosin acids, along with unreacted rosin. The amount of calcium or zinc contained in finished products of this category may vary over a wide range.

Rosin Acids - The acidic components of rosin isomeric with the acids present in oleoresin with empirical formula $C_{20}H_{30}O_2$, and derived therefrom when the oleoresin is converted to rosin by the usual commercial processes.

Rosin Oil - The relatively viscous, oily portion of the condensate obtained when rosin is subjected to dry destructive distillation: also used to describe specially compounded oils having a rosin oil base.

Rosin Spirits - The relatively light, volatile portion of the condensate obtained in the first stages when rosin is subjected to dry destructive distillation.

Rosin Standard (Grade) - Any combination or assembly of colored glasses prepared and issued by the U.S.Department of Agriculture for use in classifying rosin as to grade. Standards for the following grades have been established by or under authority of the Federal Naval Stores Act: Grades X, WW, WG, N, M, K, I, H, G, F, E, D, and FF (the latter is used only for wood rosin).

(Note) Rosin darker in color than the standard for grade D or FF is graded B. The designation "Opaque" with the grade letters OP is used to describe rosin which, because of turbid, cloudy, or nontransparent condition due to occluded moisture, excessive crystallization, or presence of foreign matter other than dirt, can not accurately be graded by comparison with any of the above described rosin grade standards.

Tall Oil - The natural mixture of rosin acids related to abietic acid, and of fatty acids related to oleic acid, together with nonacidic bodies, which is obtained by acidifying black liquor skimmings of the alkaline pulp industry.

Terpene (Hydrocarbon) - An unsaturated organic compound having the empirical chemical formula $C_{10}H_{16}$, occurring in most essential oils and oleoresins of plants; further classified as monocyclic (dipentene), dicyclic (pinene), or acyclic (myrcene), according to molecular structure.

Quality of Well Water

The location of the Gulf Naval Stores is in Section 15, R-11-W, T-7-S. The following information was obtained from U.S.G.S. Water Supply Paper 576, pages 195, 197, 199, concerning a well located in Section 4, R-11-W, T-7-S (four miles away). "No.17, Owned by U. S. Government at post office and courthouse, depth 1292 ft."

Mineral Analyses:	p.p.m.
Silica (SiO_2)	32
Iron (Fe)	0.08
Calcium (Ca)	0.6
Magnesium (Mg)	1.0
Sodium & Potassium (Na + K)	103
Carbonate Radical (CO_3)	37
Bicarbonate Radical (HCO_3)	193
Sulfate Radical (SO_4)	11
Chloride Radical (Cl)	5.0
Nitrate Radical (NO_3)	Trace
Total dissolved solids at 160°C.	292
Total hardness as $CaCO_3$	6

Rosin Specifications, ASTM

Color - USDA color standards for the grade desired by manufacturers (see definition of rosin standard)

Melting Point (capillary tube method)	140-158°F.
Acid Value	158-172
Saponification Value	167-184
Unsaponification Value	5.6 - 10.7 %
Ash	0.15 - 0.10 %
Iodine Number (Wij's Method)	205-230
Specific Gravity	1.06 - 1.09
Refractive Index	1.546 - 1.548 at 20°C.
Specific Heat	0.48 average for temperatures 88 to 266°C.)
Ignition Temperature	465°F.

Dichromate Reflux Method for Determination of Oxygen Consumed

Special Apparatus

1. Reflux apparatus, consisting of a 300-ml. round-bottomed flask with a 24/40 taper-joint neck connected with a Friedrich's reflux condenser.

Reagents and Solutions

1. Potassium dichromate, 0.2500 N
2. Sulfuric acid, concentrated
3. Ferrous ammonium sulfate, 0.2500 N
4. Indicator, O-phenanthroline ferrous complex

Procedure

1. Dilute an appropriate amount of sample to 50 ml. with distilled water in a 300-ml. round-bottomed flask with a taper-joint neck.
2. Add 25.0 ml. of 0.2500 N potassium dichromate and 75 ml. of concentrated sulfuric acid. For the best quantitative results, use 50% by volume sulfuric acid.
3. Reflux for two hours.
4. Cool, transfer the mixture to an Erlenmeyer flask and titrate the excess potassium dichromate with approximately 0.2500 N ferrous ammonium sulfate, using o-phenanthroline ferrous complex as an indicator.
5. Reflux a blank at the same time, using the same amount of reagents and substituting 50 ml. of distilled water for the sample.
6. The ferrous ammonium sulfate must be standardized daily.

Calculation

$$\text{O.C, p.p.m.} = \frac{(a-b) \times \text{normality (standard Fe)} \times 8000}{\text{Volume of sample}}$$

where O.C. = oxygen consumed
a = ml. of ferrous ammonium sulfate used for blank
b = ml. of ferrous ammonium sulfate used for sample

The following table of stumps processed and production of finished products is presented as an aid in the interpretation of the analytical result of this survey:

Daily Production Data During Survey Period

Date 1950	Stumps Processed, Tons	Turpentine Produced, Gallons	Pine Oil Produced, Gallons	FF Rosin Produced, Barrels	Limed Rosin Produced, Drums
Dec. 1	260	2960	1178	175.2	15
2	255	913	1355	170.7	15
3	260	222		170.8	
4	255	1602	2139	156.6	15
5	225			157.8	15
6	255	1484		172.9	15
7	260	1091	2544	168.7	15
8	250	1177	119	162.9	15
9	255	83	1349	164.7	
10	260	581	83	153.5	
11	225	1740	3141	126.7	15
12	210	826	1040	174.1	15
13	230	766	1389	170.6	15
14	255	1773	633	164.0	15
15	260	1743	684	174.2	15
Average	248	1211	1300	164.2	15

GULF NAVAL STORES SURVEY, UNITED STATES PUBLIC HEALTH SERVICE

Summary of Laboratory Analyses

Sample Point-Solvent Separators

Date 1950	Average Discharge GPM	Average Discharge MGD	5-day 20°C. BOD ppm	pH	Oxygen Consumed ppm	M.O. Alk. ppm	Total Solids: Total ppm	Total Solids: Volatile ppm	Total Solids: Fixed ppm
12/5	51.7	0.0744	420	6.7	388	129	217	70	147
6	54.0	.0778	790	6.3	1250	109	311	151	160
7	57.2	.0824	946	6.2	1350	124	349	179	170
8	69.8	.1005	675	6.2	1270	116	353	156	197
9	58.9	.0847	850	6.3	1510	120	305	144	161
11	67.5	.0972	934	6.3	1570	114	320	176	144
12	66.2	.0953	1180	6.1	1760	120	360	207	153
13	56.3	.0809	884	6.3	1350	117	324	152	172
14	64.3	.0926	918	6.3		116	317	159	158
15	62.2	.0896	806	6.3		114	380	222	158
Mean	60.8	0.0875	840	6.3	1310	118	324	162	162
Maximum	69.8	.1005	1180	6.7	1760	129	380	222	197
Minimum	51.7	.0744	420	6.1	388	109	217	70	144

GULF NAVAL STORES SURVEY, UNITED STATES PUBLIC HEALTH SERVICE

Summary of Laboratory Analyses

Sample Point - Drop Solution Wash (Nigre Pit)

Date 1950	Average Discharge GPM	Average Discharge MGD	5-Day 20°C. BOD ppm	pH	Oxygen Consumed ppm	M.O. Alk. ppm	Color ppm	Total Solids Total ppm	Total Solids Vol. ppm	Total Solids Fixed ppm	Suspended Solids Total ppm	Suspended Solids Vol. ppm	Suspended Solids Fixed ppm
12/5	31.3	0.0450	3600	5.3	5510	121	1000*	2140	1800	340	80	52	28
6	31.3	.0450	3240	4.5	4760	31	100	1710	1460	250	248	236	12
7	31.3	.0450	3340	5.5	5120	130	135	1590	1110	480	88	84	4
8	31.3	.0450	3010	5.5	4940	107	300	1840	1350	490	258	248	10
9	31.3	.0450	3370	5.3	5260	107	125	1750	1310	440	134	130	4
11	31.3	.0450	3120	5.5	5610	111	165	1430	1070	360	96	94	2
12	31.3	.0450	2930	6.1	4610	120	180	1460	1110	350	90	86	4
13	31.3	.0450	3520	5.5	5510	110	110	3580	3360	220	116	114	2
14	31.3	.0450	3480	5.4		103	135	1630	1140	490	176	166	10
15	31.3	.0450	2720	5.3		98	150	2010	1610	400	172	164	8
Mean	31.3	0.0450	3130	5.4	5170	104	156	1920	1540	380	146	137	8
Maximum	31.3	.0450	3600	6.1	5610	130	300	3580	3360	490	258	248	28
Minimum	31.3	.0450	2720	4.5	4610	31	100	1430	1070	250	80	52	2

* Not included in the average.

GULF NAVAL STORES SURVEY, UNITED STATES PUBLIC HEALTH SERVICE

Summary of Laboratory Analyses

Sample Point - Turpentine Separators

Date 1950	Average Discharge GPM	Average Discharge MGD	5-day 20°C. BOD ppm	pH	Oxygen Consumed ppm	M.O. Alk. ppm	Total Solids Total ppm	Total Solids Volatile ppm	Total Solids Fixed ppm
12/5	33.5	0.0482	1775	4.3	2200	34	251	138	113
6	35.7	.0514	1685	4.7	1950	48	262	111	151
7	36.9	.0531	1610	4.7	2090	55	240	105	135
8	36.4	.0525	1520	4.7	2060	52	305	121	184
9	27.7	.0398	1735	4.5	2230	37	227	102	125
11	37.3	.0538	1500	4.9	2040	49	227	113	114
12	37.0	.0532	1630	4.7	2070	49	220	105	115
13	39.7	.0572	1490	4.7	2030	39	280	114	166
14	34.5	.0497	1455	4.7		44	260	137	123
15	34.5	.0496	1210	4.7		40	286	151	135
Mean	35.3	0.0509	1571	4.7	2080	45	256	120	136
Maximum	39.7	.0572	1775	4.9	2230	55	305	151	184
Minimum	27.7	.0398	1210	4.3	1950	34	220	102	113

GULF NAVAL STORES SURVEY, UNITED STATES PUBLIC HEALTH SERVICE

Summary of Laboratory Analyses

Sample Point - Turpentine & Pine Oil Separator

Date 1950	Average Discharge GPM	Average Discharge MGD	5-day 20°C BOD ppm	pH	Oxygen Consumed ppm	M.O. Alk. ppm	Total Solids Total ppm	Total Solids Volatile ppm	Total Solids Fixed ppm
12/5	7.91	0.0114	7720	6.8	15,500	85	537	451	86
6	8.22	.0118	8760	6.8	10,800	77	1095	987	108
7	8.57	.0123	7400	6.7	12,200	85	891	759	132
8	9.60	.0138	4800	6.7	8,600	77	949	819	130
9	8.90	.0128	6760	6.7	10,300	84	279	152	127
11	8.60	.0124	8360	6.7	11,100	76	321	223	98
12	8.27	.0119	9460	6.5	14,700	91	350	263	87
13	8.80	.0127	6060	6.9	9,900	91	327	196	131
14	7.82	.0113	6480	6.9		101	285	164	121
15	9.08	.0131	9160	6.8		88	333	245	88
Mean	8.58	.0124	7500	6.8	11,600	86	537	426	111
Maximum	9.60	.0138	9460	6.9	15,500	101	1095	987	132
Minimum	7.82	.0113	4800	6.5	8,600	76	279	152	86

GULF NAVAL STORES SURVEY, UNITED STATES PUBLIC HEALTH SERVICE

Summary of Laboratory Analyses

Sample Point - Solvent Scrubbers

Date 1950	Average Discharge GPM	MGD	5-day 20°C. BOD ppm	pH	Oxygen Consumed ppm	M.O. Alk. ppm	Total Solids Total ppm	Volatile ppm	Fixed ppm
12/5	69.6	0.1002	800	6.2	1840	117	348	203	145
6	66.5	.0958	167	6.7	432	110	273	84	189
7	67.1	.0966	191	6.9	495	140	207	94	113
8	67.4	.0971	945	7.1	2860	139	341	185	156
9	63.1	.0909	175	7.1	526	134	196	79	117
11	63.3	.0912	213	6.9	425	134	198	49	149
12	66.3	.0955	204	7.2	340	138	216	47	169
13	65.5	.0943	166	7.1	441	137	225	57	168
14	66.2	.0953	180	6.9		133	217	64	153
15	67.1	.0966	248	6.9		134	232	74	158
Mean	66.2	0.0954	329	6.9	919	132	245	94	152
Maximum	69.6	.1002	945	7.2	2860	140	348	203	189
Minimum	63.1	.0909	166	6.2	340	110	196	47	113

GULF NAVAL STORES SURVEY, UNITED STATES PUBLIC HEALTH SERVICE

Summary of Laboratory Analyses

Sample Point - Plant Effluent to Lagoon

Date 1950	Average Discharge GPM	Average Discharge MGD	5-day 20°C BOD ppm	pH	Oxygen Consumed ppm	M.O. Alk. ppm	Chlorides ppm	Color ppm	Total Solids Total ppm	Total Solids Vol. ppm	Total Solids Fixed ppm	Suspended Solids Total ppm	Suspended Solids Vol. ppm	Suspended Solids Fixed ppm
12/5	828	1.1887	348	7.3	453	152		40	318	160	158	10	6	4
6	746	1.0802	454	7.0	634	136		90	395	225	170	10	9	11
7	706	1.0143	355	7.1	584	142		60	354	166	188	28	16	12
8	700	1.0053	382	7.1	666	144		100	410	250	160	20	13	7
9	739	1.0620	445	7.5	940	154		50	336	201	135	13	13	1
11	749	1.0762	450	7.1	622	135	3.2	65	333	184	149	40	34	6
12	750	1.0778	412	7.1	631	141	3.4	60	364	187	177	13	8	5
13	700	1.0061	422	6.9	666	136	3.5	80	342	164	178	62	48	14
14	699	1.0043	380	7.1		97	3.2	90	390	248	142	13	7	6
15	714	1.0258	426	7.3		155	4.2	50	392	188	204	107	102	5
Mean	733	1.0540	407	7.2	650	139	3.5	70	363	197	166	32	26	6
Maximum	828	1.1887	454	7.5	940	155	4.2	100	410	250	204	107	102	4
Minimum	699	1.0043	348	6.9	453	97	3.2	40	318	160	135	10	6	1

GULF NAVAL STORES SURVEY, UNITED STATES PUBLIC HEALTH SERVICE

Summary of Laboratory Analyses

Sample Point - Lagoon Effluent to Bayou Bernard

Date 1950	Average Discharge GPM	Average Discharge MGD	5-day 20°C BOD ppm	Sulfides as S ppm	pH	Oxygen Consumed ppm	M.O. Alk. ppm	Chlorides ppm	Color ppm	Total Solids Tot. ppm	Total Solids Vol. ppm	Total Solids Fix. ppm	Suspended Solids Tot. ppm	Suspended Solids Vol. ppm	Suspended Solids Fix. ppm
12/5	828	1.1887	380	0.1	6.8	507	153		90	332	163	169	21	15	6
6	746	1.0802	303	0.9	6.5	438	142		140	299	136	163	46	31	15
7	706	1.0143	298	1.0	6.7	403	154		125	318	128	190	14	12	2
8	700	1.0053	312	0.7	6.5	483	152		175	359	190	169	24	20	4
9	739	1.0620	240	0.3	6.7	612	145			321	145	176	12	8	4
11	749	1.0762	335	0.7	6.5	439	153	0.4	90	298	128	170	21	19	2
12	750	1.0778	348	0.5	6.7	484	148	1.0	90	331	154	177	13	9	4
13	700	1.0061	266	0.5	6.7	525	149	0.7	90	310	130	180	75	52	23
14	699	1.0043	348	0.5	6.7		144	4.1	110	307	158	149	40	23	17
15	714	1.0258	317	1.1	6.8		146	3.3	120	354	167	187	81	59	22
Mean	733	1.0540	315	0.63	6.7	486	149	1.9	115	323	150	173	35	25	10
Maximum	828	1.1887	380	1.1	6.8	612	154	4.1	175	359	190	190	81	59	23
Minimum	699	1.0043	240	0.1	6.5	403	142	0.4	90	298	128	149	12	8	2

GULF NAVAL STORES SURVEY, UNITED STATES PUBLIC HEALTH SERVICE

Summary of Laboratory Analyses

Sample Point - Stump Washer
(Operates only 16 hours a day)

Date 1950	Average Discharge GPM	Average Discharge MGD	5-day 20°C BOD ppm	pH	Oxygen Consumed ppm	M.O. Alk. ppm	Color ppm	Total Solids Total ppm	Total Solids Vol. ppm	Total Solids Fixed ppm	Suspended Solids Total ppm	Suspended Solids Vol. ppm	Suspended Solids Fixed ppm
12/5	182	0.1749	1990	6.4	36,200	99	1750	29,000	12,800	16,200	25,200	11,000	14,200
6	205	.1966	2480	6.6	20,700	102	1600	18,200	9,000	9,200	17,300	8,400	8,900
7	195	.1873	1300	6.9	15,200	91	1250	11,400	5,800	5,600	11,200	5,700	5,500
8	198	.1905	850	6.9	13,100	79	1000	14,800	6,800	8,000	13,200	6,200	7,000
9	206	.1980	1430	6.9	11,500	83	1250	12,800	6,600	6,200	11,200	5,800	5,400
11	198	.1899	1450	6.9	13,000	93	1000	13,800	6,900	6,900	13,200	6,800	6,400
12	194	.1858	1150	6.9	12,300	92	750	15,400	7,200	8,200	12,200	5,500	6,700
13	206	.1980	1005	6.9	9,600	97	925	13,000	5,800	7,200	10,700	5,100	5,600
14	194	.1864	2925	6.7		47	2250	54,600	22,000	32,600	44,300	17,300	27,000
15	177	.1696	815	7.4		97	750	12,200	5,500	6,700	10,900	5,400	5,500
Mean	196	0.1878	1540	6.9	16,400	88	1250	19,500	8,800	10,700	16,900	7,700	9,200
Maximum	206	.1980	2925	7.4	36,200	102	2250	54,600	22,000	32,600	44,300	17,300	27,000
Minimum	177	.1696	815	6.4	9,600	47	750	11,400	5,500	5,600	10,700	5,100	5,400

GULF NAVAL STORES SURVEY, UNITED STATES PUBLIC HEALTH SERVICE

Summary of Laboratory Analyses

Sample Point - Bayou Bernard Receiving Water
(Surface sample, 20 feet from shore, at lagoon discharge)

Date 1950	5-day 20°C BOD ppm	Sulfides as S ppm	pH	Oxygen Consumed ppm	M.O. Alk. ppm	Chlorides ppm	Color ppm	Total Solids			Suspended Solids		
								Total ppm	Vol. ppm	Fixed ppm	Total ppm	Vol. ppm	Fixed ppm
12/11	195	0.2	6.7	350	104	282	80	687	93	594	58	49	9
12	191	0.2	6.7	366	109	320	80	759	108	651	81	69	12
13	265	0.2	6.7	457	138	165	100	544	126	418	96	64	32
14	254	0.6	6.7		107	324	90	761	106	655	69	62	7
15	189	0.5	6.7		124	130	90	488	140	348	75	72	3
Mean	219	0.34	6.7	391	116	244	90	648	115	533	76	63	13

GULF NAVAL STORES SURVEY, UNITED STATES PUBLIC HEALTH SERVICE

Summary of Laboratory Analyses

Sample Point - Turbine Condensate Pond Effluent

Date 1950	Average Discharge GPM	Average Discharge MGD	5-day 20°C BOD ppm	pH	Oxygen Consumed ppm	M.O. Alk. ppm	Color ppm	Total Solids Total ppm	Total Solids Vol. ppm	Total Solids Fixed ppm	Suspended Solids Total ppm	Suspended Solids Vol. ppm	Suspended Solids Fixed ppm
12/5	40.9	0.0589	4.38	10.5		372	35	578	94	484	40	26	14
6	170.2*	.2450*	46.4*	9.7*	147*	148*	160*	455*	168*	287*	60*	21*	39*
7	31.8	.0457	6.34	10.6		417	55	642	84	558	45	20	25
8	43.9	.0633	4.32	10.5		332	40	586	111	475	77	34	43
9	46.7	.0672	2.72	10.5		378	45	576	118	458	32	19	13
Mean	40.8	0.0588	4.44	10.5		375	44	596	102	494	49	25	24

* Heavy rainfall on this date, flow included considerable yard drainage; results not included in average.